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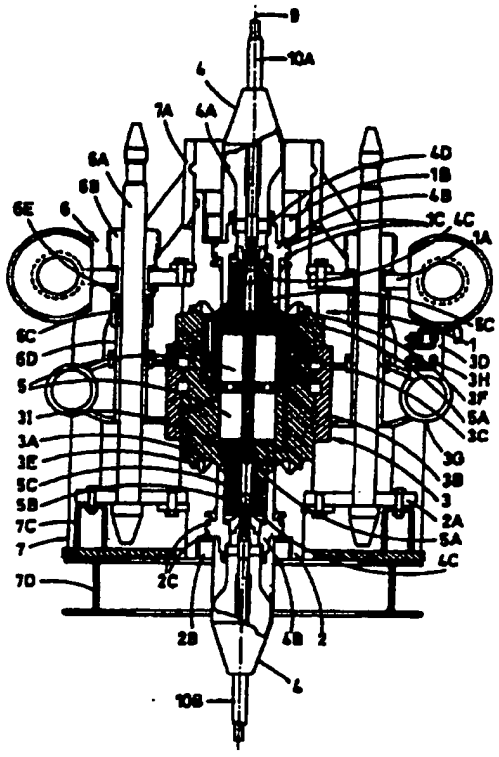
(57) Abstract

A coupling– and switch system for subsea electrical power distribution of the type in which fluid–filled contactor housings are utilized. The coupling and switch system includes two mutually spaced contactor housings (4B, 4B) mounted along a common centerline. In the interspace between the contactor housings there is provided a coupling housing or a so called middle piece (3) having contacting elements, and the middle piece when or after mounting between the contactor housing is anchored in a fluid–tight manner thereto by axial movement of one or both contactor housings. The contactor elements (5A, 5C, 5C) in the middle piece can be moved into respective contactor housings with the middle piece in mounted position therein, said contactor element number of which may be one or several, according to the number of electrical power phases.



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A COUPLING- AND SWITCH SYSTEM FOR SUBSEA ELECTRICAL POWER DISTRIBUTION.

The invention relates to a coupling- and switch system having one or several through-going electrical conductors, substantially for subsea connection of a single or multiphase high voltage system, specially, an underwater separable and re-connectable (Wet make/break) electrical coupling.

A typical application of the coupling- and switch system is three phase high voltage connection in the range of 1-36 kV or higher, for example, in connection with coupling of subsea transformators, further electrical operation of pumps for reinjection of separated water, in addition to operation of other electrical equipement located on the sea bed. The coupling- and switch system has an electrical disconnecting function (disconnecting switch) which can be used for in situ or remotely operated, temporary or permanently coupling of different electrical parts from each other.

The development within offshore oil- gas exploitation has in the recent years been directed to subsea installations for processing and transport of oil and gas. These subsea installations are increasingly replacing the traditional platforms in which oil and gas was transported up to the platform for further processing and transport, for example. This development of subsea production-, processing- and transport systems has resulted in an increasing need for the supply of large quantities of electrical power. The combination electrical power (high voltage) and salt water results in that coupling of electrical cables, for example, to other electrical equipment on the sea bottom, and specially the operation of these during time, is very difficult and risky, and hence is a substantial challenge for the development of technology within this area. A typical area of use for det present invention is a subsea system (installation) for separation of water from crude oil in which supplied hydraulic or electricall power is required in order to facilitate reinjection of separated water by operation of injection pumps. Electrical power must here be supplied through an electrical system facilitating high voltage transfer from a surface installation to the subsea installation.

Coupling devices for the above object presently are substantially based on liquid filled couplings comprising a male part an a female part. During connection the male part is kept steady and the female part is moved against and in coupling engagement with the male part manually or by use of external tools. It has been experience that the female part

is the weak part in this coupling, and water ingress during a period of time is a problem, resulting in that this type of coupling has a limited operational life.

As examples of the prior art technique within the area references are made to the following publications: EP 48601, EP 0251655, EP 493375, WO 9016095 OG GB 2124038.

The primary object of the present invention is to develope an improved coupling- and switch system, which provides improved safety against water ingress and thereby extended operational life of the system in use.

A further object of the invention is to developed a system which is simple to service and which preferably includes a replaceable coupling unit.

A further object of the invention has been to develop a coupling system which can be utilized as a coupling system and as a switch system for one or several through going electrical conductors.

A further object has been to develop a coupling and swithing system which is particularly suited for high voltage applications, for example 1-36kV or higher.

The invention is in its main features based on a coupling system comprising two mutually spaced contactor housings mounted along a common center line, and in that a coupling housing or so called middle piece is provided within the interspace between the contactor housings, the middle piece having contacting elements which can be moved into contact with the respective contactor housing, and in that the middle piece after mounting between the contactor housings are liquid proof anchored to this by axial movement of one or both contactor housings, since it in the middle piece is provided contactor elements which can be moved into the respective contactor house with the middle piece in mounted position.

The middle piece including corresponding parts may be released and retrieved from mounted position between the contactor housings by pulling ut away from the centre line through said housings, when one or both of these is (are) released axially from the middle piece. The middle piece and the contactor housings are provided with a channel system intercommunicating when the middle piece including contactor housing is mounted in position, which facilitates flushing of the coupling system in interconnected position.

The coupling- and switch system according to the present invention has a robust (sturdy) construction wherein the contacting area between the male og female parts in a

controlled way is cleaned from sea water etc. and supplied with dielectric fluid for the operational phase. The coupling further includes replaceable female part with switching function. By the coupling according to the invention it is thereby achieved a sea waterproof coupling having switching function and good serviceability. This is achieved according to the invention by a coupling- and switch system according to the independent claim 1, and further described in the dependent claims 2-9.

The present invention is explained below by references to the attacted figures wherein:

fig. 1 shows a coupling and switch system according to the invention in an assembled operational state.

fig. 2 shows the middle piece (female part) for inserting into the coupling according to fig. 1,

fig. 3 shows the male part of the coupling provided on a frame (skid),

fig. 4.1-8 shows the steps for coupling the coupling- and switch system, and

fig. 5.1-6 shows stepwise the disconnecting/switching funtion of the coupling- and switch system according to the invention.

With reference to the figures and particular figure 1, an embodiment of the coupling- and switch system is shown comprising two opposing coupling flanges 1,2 having build in «electrical malepart» 4C, 4C in addition to an interlocated middelpiece 3 having build in «electrical female parts» 5B, 5B in addition to contactor pins 5A, 5A. These are arranged in a telescopic structure (back-to-back). The middle piece 3 can be installed and disconnected/replaced by using a remote operated vessel (ROV). In assembled state the assembly consisting of upper flanges 1, middele piece 3 and lower flange 2, forms a container in which entrapped seawater can be flushed out and replaced by a proper medium. After flushing the telescopic structure of the middle piece 3 is activated, such that each «electrical female part» 5B, 5B hydraulically is pushed into engagement with the respective «electrical malepart» 4C, 4C build in as mention above in the upper flange 1 and the lower flange 2. The flanges 1, 2 can be arranged in a vertical or horizontal arrangement. The coupling device according to the present invention can be utilized wherein all phases (three) of the elctrical cable is connected by means of an assembly, eventually one assembly per phase. Hence, the «electrical female part» 5B typically

includes three pins, one for each of the three phases, instead of one pin as shown in the attached drawings.

Below is a designation of the single components with reference numerals to the attached drawings. The upper vertical is designated by upper flange 1, locking plate 1A, nut 1B and metal sealing ring (radial) 1C. The lower vertical assembley is designated by lower flange 2, locking plate 2A, nut 2B and metal sealing ring (radial) 2C. The middle female part is designated by the middle piece 3, flushing housing 3A for fluid I/fluid II/fluid III. The flushing housing ring 3B, flushing nozzle 3C, ROV valve 3D, metal sealing ring 3E for the flange 2, metal sealing ring 3F for the flange 1, manifold/funnel 3G, pipe system 3H (typical four pipes) and channels 3I. Electrical connector part is designated by male part 4, penetrator 4A, contactor housing 4B, contactor pin 4C, 4C and metal sealing ring (axial) 4D. Electrical coupling part female part 5, contactor pins 5A, shuttle sleeve and shuttle 5B, 5B including eventual compensation chambers (eventual fluid 3) 5C. Tension bolts 6, bolt 6A, adjustment nuts 6B, split sleeve 6C, bolt housing 6D and thrust bearing 6E. Fixedly mounted framing 7, locking ring with ROV lock in the upper framing (part of the above located module) 7A, lower framing (framework) (part of the below located module) 7B, stamping piece 7C, frame lower part 7D. Center line 9, upper cable 10A and lower cable 10B.

Examples of the above mentioned fluids are fluid I: destillated water etc., fluid II: hydroscopic liquid, methanol, synthetic oils etc., fluid III: dielectric fluid for example silicon oil, synthetic oils etc. In addition more than one ROV valve could be included.

The part systems consisting of the middle piece 3 and tensioning bolts 6 form an assembly which can be installed or disconnected/replaced by using a ROV. It should be noted that the remote operated vessel including tool is not shown in the drawings, but this tool will cover the functions related to transport, guiding, adjusting in addition to tensioning of the tension bolt 6 for the interconnection. This equipment represents prior art technique and therefore not discussed in the specification. A flushing system for injection of cleaned fluid I/fluid II/fluid III for dedicated, built-in tanks 1, 3 or closed dry/cleaning circuit or fluid I/fluid II/fluid III is also included in the system. Underpressure in relation to the surroundings (environment) can be used to effect circulation of any of the above fluids.

With reference to fig. 4.1-8, the sequences for interconnecting the coupling- and switch system according to the invention will now be stepwisely described. Fig. 4.1 shows

the electrical male coupling parts 4 arranged on a assembly of framework 7A, 7B and opposingly located in axial alignment and with mutual spacing. The assembley of framework 7A, 7B with the male parts 4, 4 mounted onto the upper cable 10A and the lower cable 10B, respectively, typically will be located on the sea bottom. Fig. 3 shows this part of the coupling prior to inserting the middle piece 3. In fig. 2 the middle piece 3 including tensioning bolt 6 is shown in a separated state. Fig. 4.1 further shows the middle piece 3 including bolts 6A and the hydraulic activating system. The middle piece 3 including bolts A is inserted by means of a ROV.

Fig. 4.2 shown the middle piece 3 lowered down against the lower male part 4. In this position a small gap between the two said parts will still exist. Fig. 4.3 shows the next step in the operation, wherein the upper male part 4 now is lowered down against the middle piece 4, and a small gap between the two parts will also exist here. In fig. 4.4 the bolts 6A is lifted somewhat up. In fig. 4.5 the bolts are tensioned, and a gap a is provided. In fig. 4.6 the nuts 6B are tensioned, such that the gap a is closed. Fig. 4.7 shows the flushing operation of the enclosed chamber by means of said fluid I/II/III. The last step fig. 4.8 shows the electrical connection completed between the female and the male part in that the shuttles 5B, 5B of the female part is slided outwardly and into engagement with the male parts 4C, 4C by means of hydraulic activation.

In fig. 5.1-6 sequences for disconnecting the coupling- and switch system according to the present invention are shown. Fig. 5.1 shows the coupling- and switch system in a completed assembled state, wherein the power supply now is turned (switched) off. In fig. 5.2 the electrical disconnection is carried out in that the shuttles 5B, 5C now are pulled back by means of hydraulic power supplied by means of a ROV. Fig. 5.3 shows a sequence in which the disconnection of the bolts is started. In fig. 5.4 the lifting off of the upper male part 4 is commenced. In fig. 5.5 the lifting of the upper male part 4 is completed and the lifting of the middle piece 3 is commenced. In fig. 5.6 the middle piece 3 is completely released and ready to be taken up by the tool of the ROV and brought to the surface. The middle piece 3 can be used as an electrical disconnecting switch by reversing the coupling sequence with the result as shown in fig. 5.2. Then the electrical cables 10A, 10B temporarily or permanently can be separated from each other without the coupling being opened against sea water. Thereafter the one cable, 10A for example, can be put under voltage however, on the assumption that the gap between the

contactor pin 5A and the bolts 4C (in the end 10B) is sufficient to prevent jump spark when the voltage is turned on.

The coupling- and switch system according to the present invention has a robust, service-friendly and a very safe, high integrety structure, especially regarding ingress of sea water during electrical interconnection, in addition to preventing ingress of water during service life. The coupling system is very flexible, and in a distribution system on the sea bed for example, it can be preferable to electrically switch off parts of the system in periods, and this is achieved in a simple way by the switching function as explained in fig. 5.1-2. As is explained also in fig. 5.1-6, the system is very service-friendly and the parts with the traditionally highest failure rate (the female part, middle piece 3) can be disconnected and brought to the surface for service operations.

A common problem with any interconnection system is how the interconnection movement can be taken care of. The coupling arrangement according to the invention has a solution wherein a very reduced motion from the upper flange 1 which has a built-in electrical male part 4, is utilized, and this is achieved by a middle piece 3 having telescopically provided electrical female parts 5B, 5B retracted, is located between the upper and lower flange 1, 2. These can be activated by a ROV, such that an internal movement of the middle piece 3 provides electrical coupling under condition of static supported electrical male parts.

Electrical couplings for connection in sea water has been based on direct interconnection of the male and female parts in sea water. This is carried out due to limited diver capasity during, or assistance to, the interconnection itself. The system according to the invention describes a solution wherein this process is mechanized. A closed metallic sealable tank is created prior to the interconnection itself, in order to circulate out entrapped sea water prior to the interconnection itself between the male and female part, such that this can be carried out in an environment which is friendly in relation to ensuring isolation and prevent sea water ingress. To control the circulation in order to replace sea water within the coupling, prior to a simple interconnection, it is in this embodiment of the invention created a forced circulation way. This includes two chambers which are separated by an elastomer sealing (O-ring). Chamber 1 is male part «pocket» having a circulation ability completely in the bottom, and number two is a collection chamber representing a sea water barrier, inside the main metal sealings at the end of the circulation.

The circulation is achieved via the ROV frame/manifold which is built into the side mounted funnels (manifold in the one funnel) of the middle piece, chamber and in addition to that the form of the flushing ports and manifold will be optimized based on fluid mechanical analyses where turbulent flow in the male part «pocket» will be optimized. The flushing function for example, will be coupled to one or several closed circuits in the ROV-skid (tool). In order to improve the replacement of entrapped sea water in the middle piece, refer to female «pocket», discontinuous flushing can be achieved by temporarily creating an under- pressure which is used to suck out sea water, and thereby suck in fluid I, II and III in each turn. Therefore, the electrical coupling itself is carried out in fluid III, dielectric fluid.

After the flushing is completed the electrical connection itself will be hydraulically effected by communication with the ROV-skid (tool), through hydraulic manifold in the side-mounted funnels of the middle piece. The telescopic coupling consists of two electrical female parts in «back-to-back»-arrangement, which substantially each contains an electrical conducting sleeve (contacts). These are driven out by hydraulic power such that electrical contact with static contact (pin) in each electrical male part is achieved. The current (electrical power) path from live cable 10A in the upper male part 4, for example, will be through the male part 4C further to the live sleeve 5B of the shuttle, and therefrom to the contactor pin 5A of the female part, electrically isolated from the chamber wall in part 3A and further down to the live sleeve 5B in the shuttle of the female part, and therefrom to the lower contactor pin 4C of the male part, which is finally connected to the cable 10B out of the coupling- and switch system.

It should be noted that the live sleeve of the shuttle typically is constructed with flexible contact elements in each end to establish safe eletrical coupling with contactor pin 5A and the male part's contactor pin 4C, 4C.

Previous experience shows that the electrical female parts are less reliable than the male parts. This is due both to the unavoidable complexity in that they include dynamic elastomere type gaskets, in addition to that wiper/drying rings are exposed to wear with the following possibility of causing water ingress. The present solution is characterized in that the electrical female parts are replaceable since they from a modulation standpoint is built into a telescopic «bridge». The middle piece includes this telescope coupling, and together with the side-mounted funnels in addition to the tensioning bolts, this results in an

arrangement which in its entirety can be replaced by means of ROV/ROV-skid. This is a substantial difference compared with the traditional solutions, wherein the first or the second module must include a female part built in as a permanent part, replaceable only by retrieval of said modul.

In connection with electrical contacts it is a known problem that the contact points can be exposed to wear, additionally, wear can be originated due to particle expelling during spark jump for switches. The present coupling- and switch system has a solution in which the male parts have replaceable electrical contacts. These are provided by means of a principal with a «saver sub» often utilized in the subsea industry in order to make it possible to correct errors if damage has occured on a coupling flange ,for example. Replacement of male part electrical contacts is carried out with a, for the purpose ,special middle piece functioning as a tool for placing said contactor. After bringing the old contactor to the surface, the special middle piece is charged with new contactors, which later is located in position by reversing the disconnecting/retrival procedures.

In the attached figures the coupling systems according to the invention is shown for horizontal insertion of the middle piece. Another alternative would be vertical insertion of the middle piece, as a «mini» middle piece between two flanges containing male parts, referred to as horizontal, intermodular coupling. A closed circulation circuit for removal of sea water within the middle piece prior to electrical coupling, as described above, can be utilized.

The present invention is based on that the shuttle 5C,5C includes an arrangement in which an isolating material is selected immediately around the electrical conducting sleeve 5B, 5B in addition to that the electrical isolation is achieved by the shuttle 5C, 5C manufactured in a non-conducting material. It is possible to include compensation chambers in the shuttle 5C, 5C, which can be filled with fluid III.

There exist today limited experience with high voltage electrical couplings, interconnected in the sea water. Experience has shown that couplings having substantial lower voltage, 200-400 V, have started to lose isolation resistance after a varying time in the sea water, typically 6 to 18 months. It is excluded that small amounts of water left after coupling can explain this tendency, and the industry has made the conclusion that water absorbation/leakage related to non-metallic material exposed to hydrostatic pressure, probably is the cause. The object of the present solution is to limit the water ingress by

completely isolating the vital electrical components from sea water by use of metal sealings (gaskets). The present coupling system includes the following sealings provided with metal-to-metal-connections: at each end of the middle piece 3, securing of the male part in the middle piece, in penetrator by securing of «glass wall», separating the middle piece, having welds for metallic sealing, hydraulic communication from manifold in funnel by use of pipe system, in addition to metal seat valves used for disconnecting of the said pipe system. A complete and consequent replacement of the elastomer sealings with metallic sealings, is one of the characterzing features of the present coupling- and switch system.

It is previously known that use of tenisoning bolts is a more rational way to pretension bolts in a flange connection. The present solution utilizes this principal of objective improved reasons which is related to the need of weight reduction. The solution utilizes two bolts symmetrically located on each side, to pretension the assembly; flange 1 - middle piece 3 - flange 2. For corresponding two bolts solutions which utilize tensioning of nuts, the need to syncronizing two «rotating» actuators, refer to hydraulic motors/plannet gears, is evident. These can be achieved by an intermediate mechanical gear mechanically coupling the two hydraulic motors. This solution includes a substantial weight, and therefore are not suited for applications in which the ROV carries the tool (skid). Therefore, the present solution includes pretensioning of the bolts directly, and syncronizing is achived in a very simple way by tensioning cylinders parellelly coupled to the pressure side, which result in equalized, even pressure for pretensioning of the bolts.

Axial joining (pin and shuttle) reduces the danger for forces existing in connection with electrical live elements in magnetic field, which is effected by conducting parts, leading to disconnection. Detailed calculations with the objects of introducing structural provisions ensuring a forcewise (magnetically induced force) unbalance resulting in a driving effect causing the shuttles to maintain connected position. This is intensionally done by controlling the magnetic field at the contactor points. Further, enclosed hydraulic volum (metalic sealings) will provide hydraulic locking, which prevents undesired disconnection during service.

PATENT CLAIMS

1. A coupling- and switch system for subsea electrical power distribution of the type in which fluid-filled contactor housings are utilized, wherein the coupling and switch system includes two mutually spaced contactor housings (4B, 4B) mounted along a common centerline (9), and that in the interspace between the contactor housings there is provided a coupling housing or a so called middle piece (3) having contacting elements (5A, 5B), and that the middle piece (3) when or after mounting between the contactor housings (4B) is anchored in a fluid-tight manner thereto by axial movement of one or both contactor housings, and that contactor elements (5A, 5B) in the middle piece (3) can be moved into respective contactor housings (4B) with the middle piece (3) in mounted position therein, said contactor element number of which may be one or several, according to number of electrical power phases.

2. A coupling- and switch system with one or several through-going electrical conductors, wherein

a supporting framework (7A, 7B),

two opposing contactor housings (4B, 4B), axially aligned with mutual interspace provided in the framework (7) and located along a common center line (9),

a replaceable middle piece (3) provided in the interspace and located along said center line (9),

which middle piece (3) is axially interconnected with the contactor housings in the operational state as a unit,

which middle piece (3) is provided with one or several centrally arranged shuttle chambers (5, 5),

two in the shuttle chambers arranged shuttles (5C, 5C) having electrical contactor means to the shuttle chamber (5),

which shuttles (5C, 5C) are independently, axially movable within the shuttle chambers (5, 5),

which shuttles (5C, 5C) are connected to means for movement in and out of the contactor housings (4B, 4B), respectively for establishing a through-going electrical conductor from the one (first) contactor housing to the other (second).

bolts are made of a conducting material, such that when the shuttles (5C, 5C) are located in the contactor housings (4B, 4C) an electrical conductor for one or several power phases, is established from the one contactor housing to the other.

8. A coupling- and switch system as stated in claims 1, 2 or 3, wherein the middle piece (3), the shuttles (5C, 5C) and contactor housings (4B, 4B) are provided with a closed channel system (3I) communicating in a closed system when the shuttle housings (5, 5) are located within the contactor housings (4B, 4B), and in that inlet means are provided for the channel system of the middle piece.

9. A coupling- and switch system as stated in claim 2, wherein the channel system (3I) for fluid includes outlet, respectively inlet, in the channel in the middle piece (3) in both endes on each sides of the respective shuttle (5C, 5C) and in the same way channels communicating with the inlet (outlet) both at the mouth and the bottom of the respective contactor housing (4B, 4B), which channel systems (3I) for through-flowing of fluid can be used both for flushing out sea water, injecting di-electric fluid, in addition to axial operation of the shuttles (5C, 5C) to position in the contactor housings (4B, 4B), in addition to retracted position in the middle piece (3).

10. A coupling- and switch system as stated in anyone of the previous claims, wherein the contactor housings (4B, 4B) is supported on a frame work (7A, 7B), at least one of the frame work is provided axially displaceable and having parallel pair of bolts, and is (are) axially powerwise displaceable between and external, respectively internal, position having the effect that the middle piece (3) including corresponding means after insertion between the flanges (1 and 2) can be fixedly clamped between flange (1) and flange (2) respectively, including the contactor housings (4B, 4B) by displacing the one flange, containing the contactor housing (4B) towards the other, simultaneously the intercommunicating channel system (3I) being positioned.

11. A coupling- and switch system according to anyone of the previous claims, wherein the contactor pin (4B) of the contactor housing is provided within the inner circumferential surface of the conducting sleeve (5B) of the shuttle, whereby the contactor

pin (4C) and the shuttle sleeve (5B) when connected (live) has a metal based sealing against sea water ingress from the outside, since this is achieved by the securing of the contactor housing (4B) in the flange (1, 2), securing of penetrator (4A) together with the external structure of the middle piece (3).

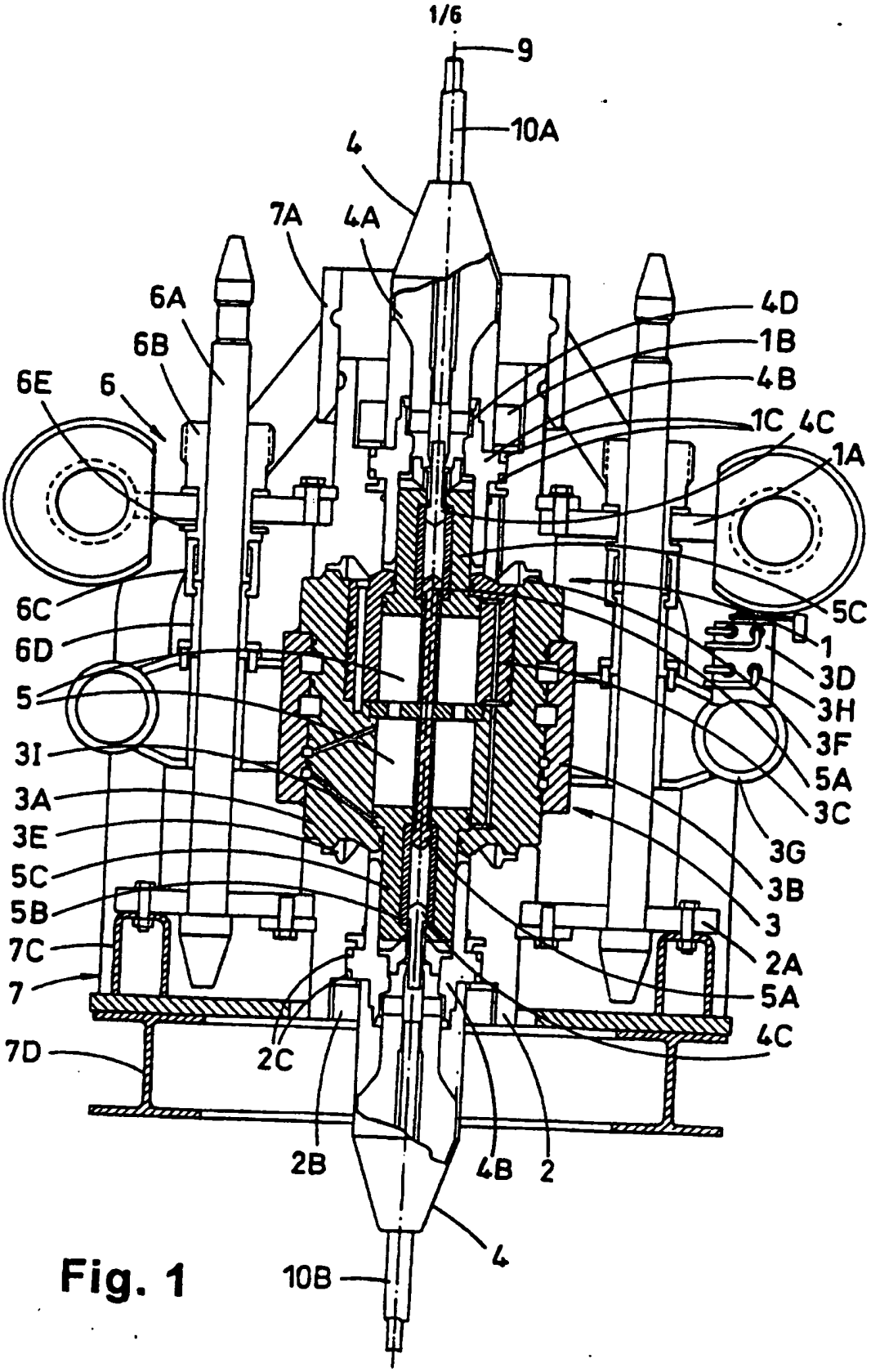
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Fig. 1

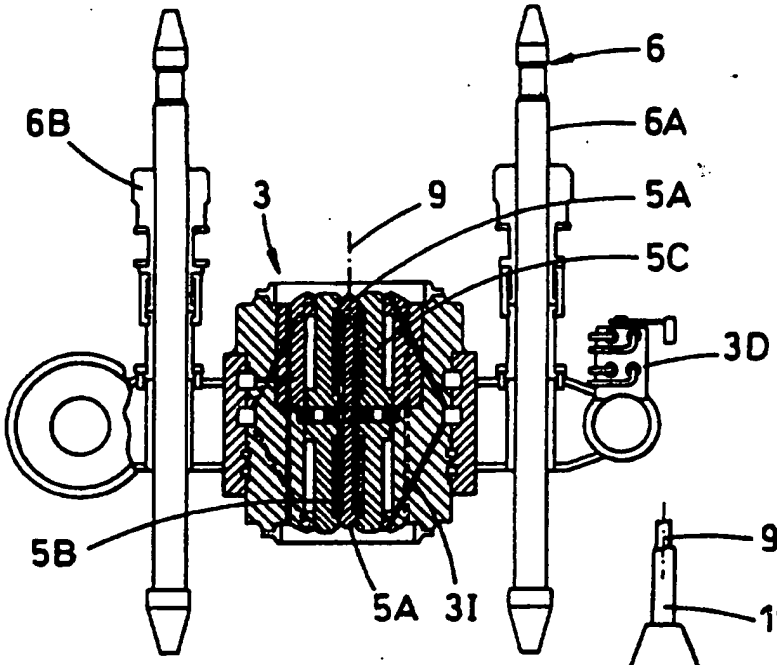

Fig. 2

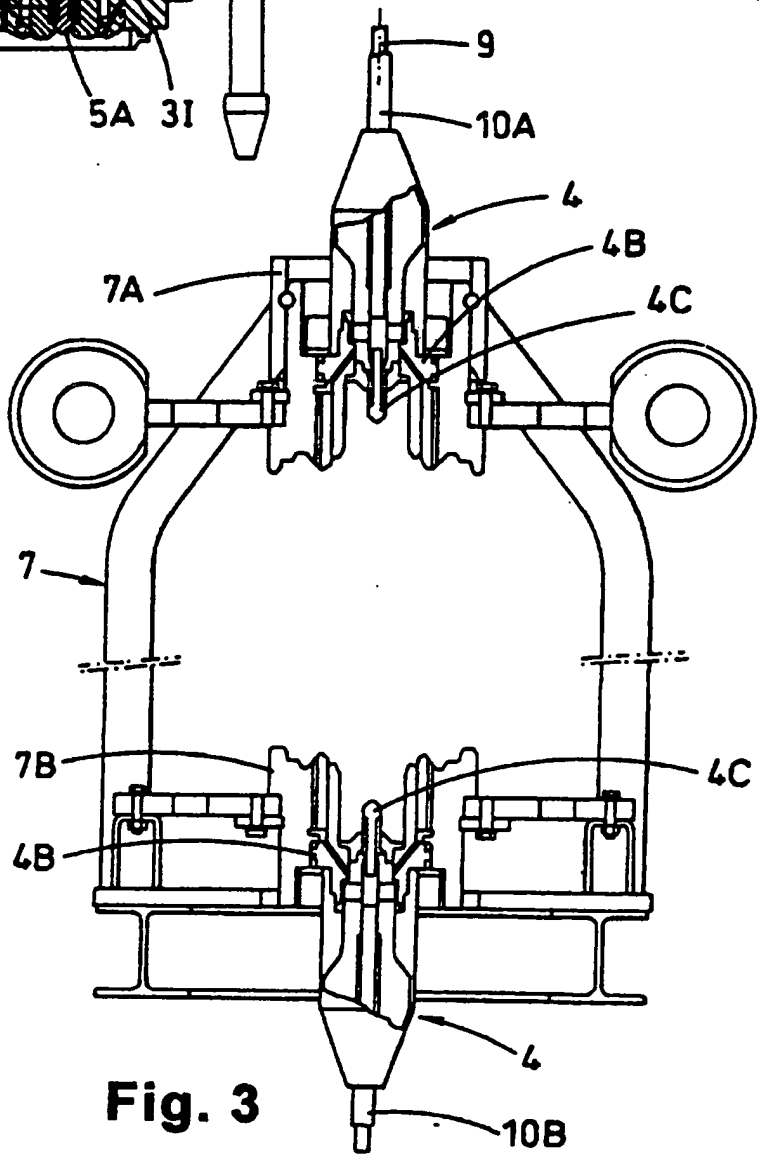

Fig. 3

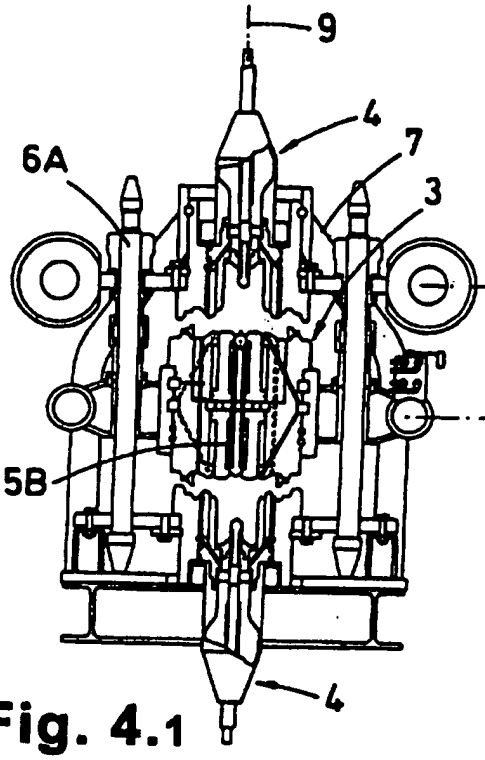

Fig. 4.1

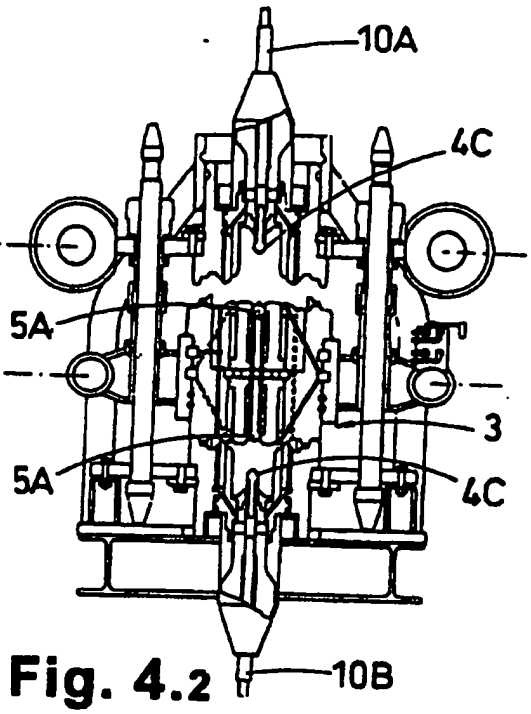

Fig. 4.2

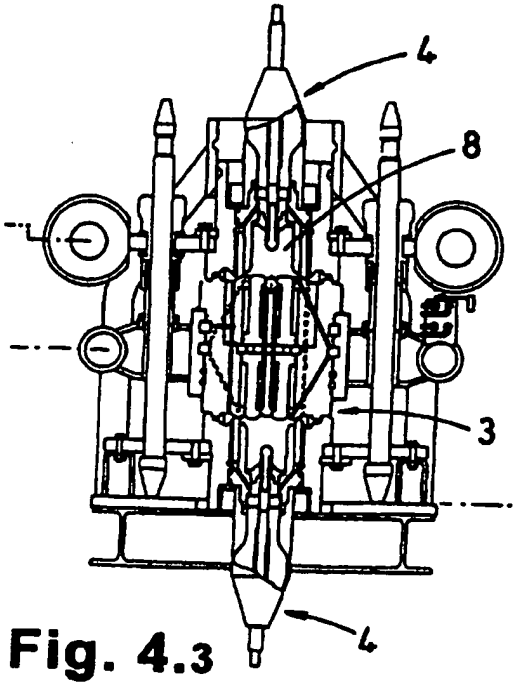

Fig. 4.3

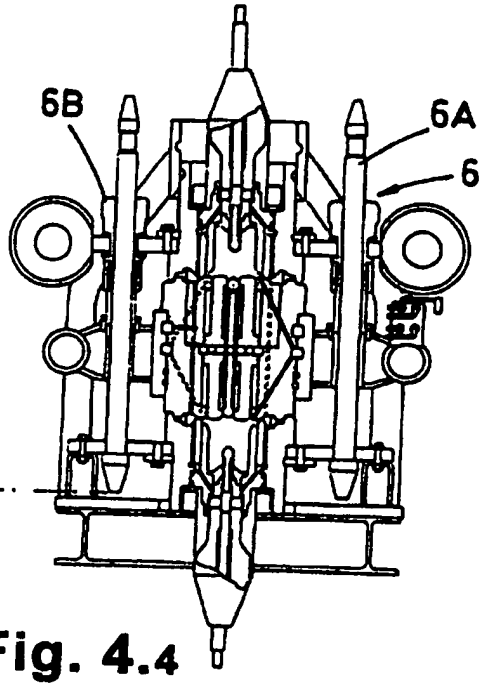

Fig. 4.4

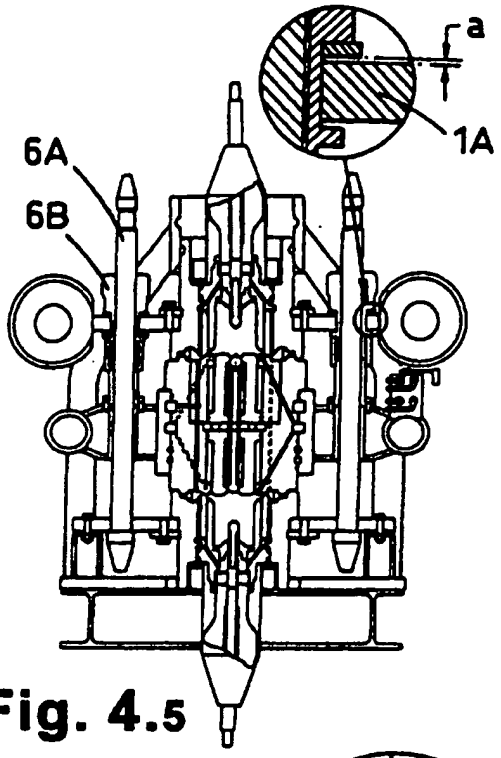

Fig. 4.5

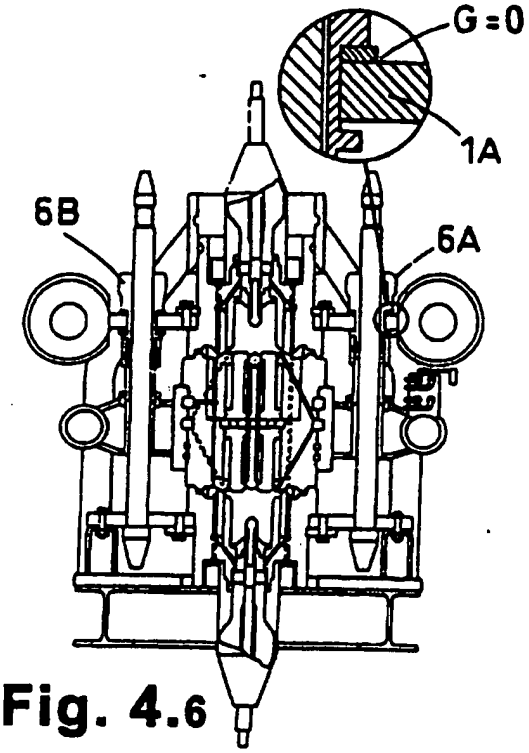

Fig. 4.6

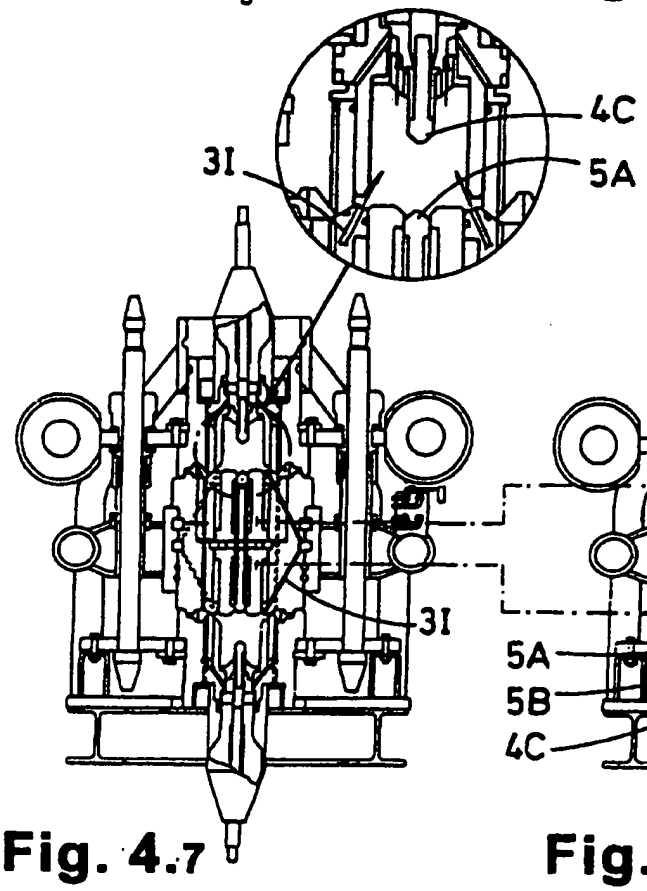

Fig. 4.7

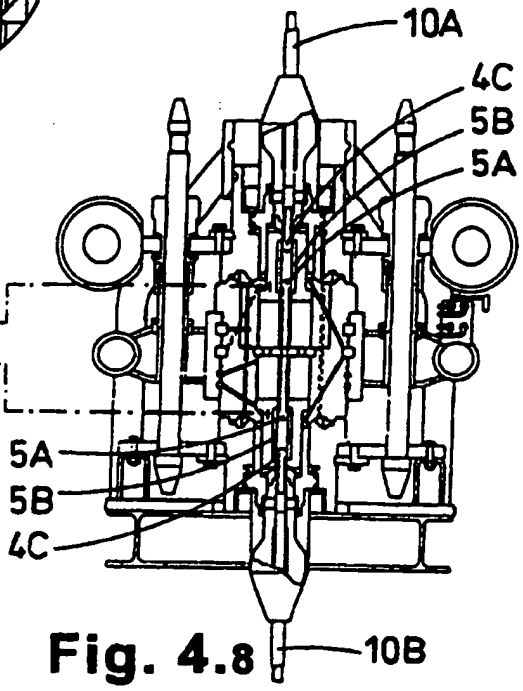

Fig. 4.8

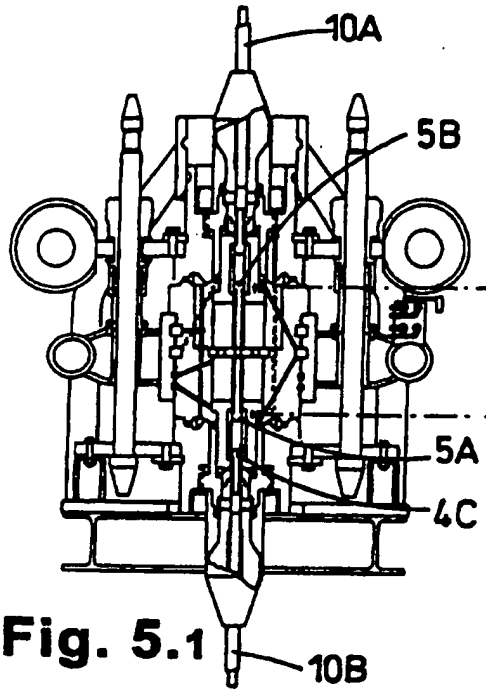

Fig. 5.1

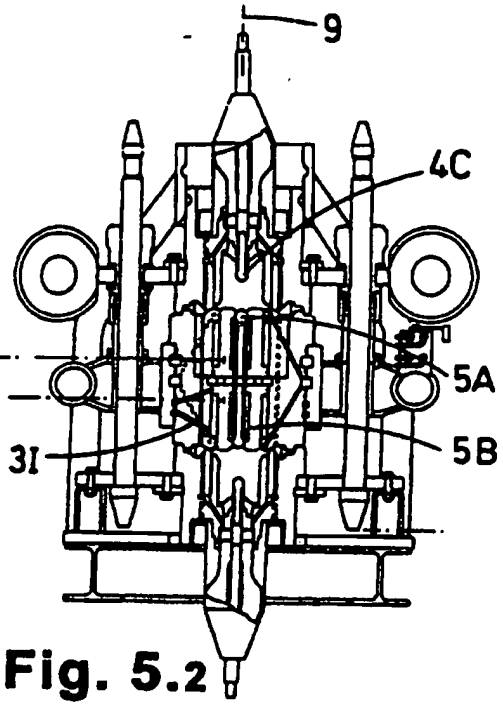

Fig. 5.2

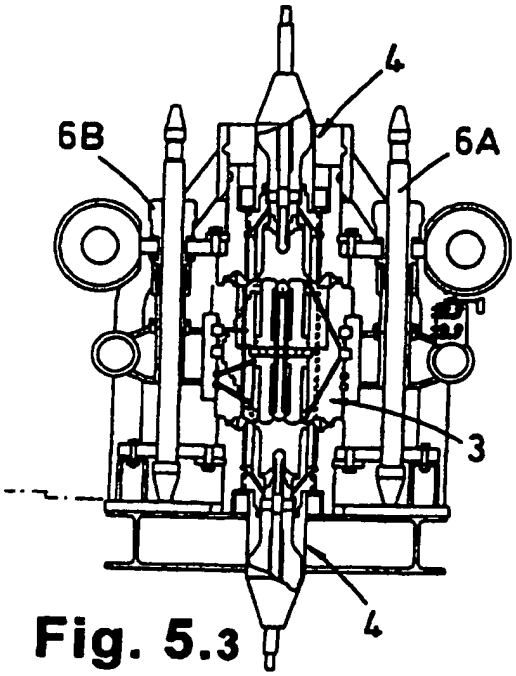

Fig. 5.3

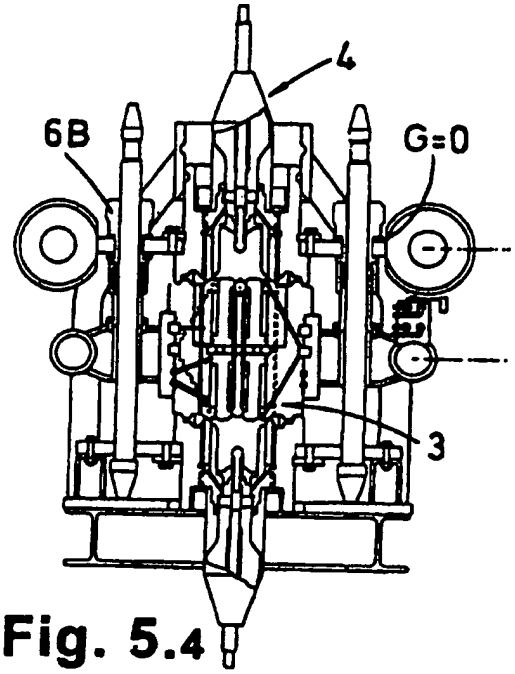

Fig. 5.4

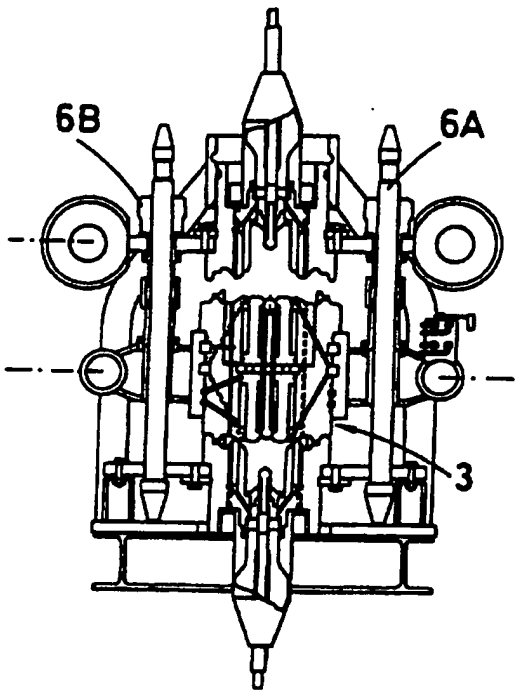

Fig. 5.5

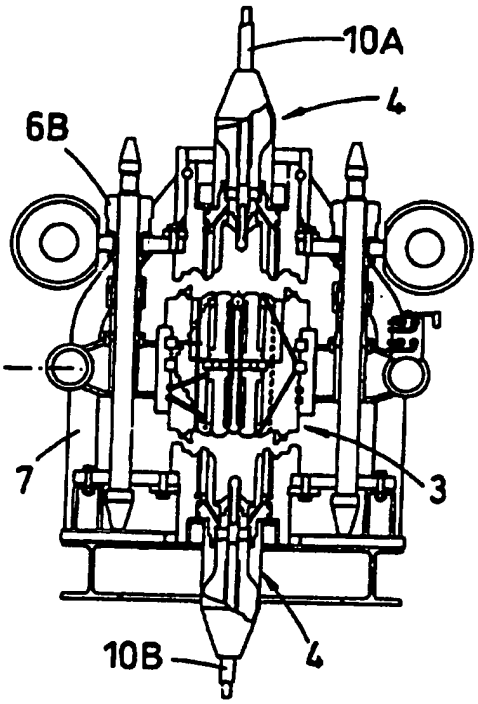

Fig. 5.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 97/00301

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01R 13/523, H01R 3/00, H02G 15/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2037498 A (BICC LIMITED), 9 July 1980 (09.07.80), page 1, line 29 - line 81; page 1, line 125 - line 129; page 2, line 1 - line 119, figure 1, abstract --	1,3-5,8
Y	US 4304456 A (M. TAKAKI ET AL), 8 December 1981 (08.12.81), figure 1, claim 1, abstract --	1,4
Y	GB 2124038 A (TRONIC ELECTRONIC SERVICES LTD (UNITED KINGDOM)), 8 February 1984 (08.02.84), page 3, line 30 - line 130; page 4, line 1 - line 12, figure 1, abstract --	3

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 February 1998	24 -02- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Falk Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 97/00301

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0727845 A2 (TESCORP SEISMIC PRODUCTS, INC.), 21 August 1996 (21.08.96), column 6, line 35 - line 40, figure 1, claim 1, abstract	5
Y	EP 0251655 A1 (TRONIC ELECTRONIC SERVICE LIMITED), 7 January 1988 (07.01.88), column 2, line 12 - line 40, figure 2, claim 1, abstract	8
A	EP 0048601 A2 (CAIRNS, J.L.), 31 March 1982 (31.03.82)	1-11
A	US 4722695 A (W. ZWICKER ET AL), 2 February 1988 (02.02.88)	1-11
A	US 4880390 A (W.H. BRACKMANN, JR. ET AL), 14 November 1989 (14.11.89)	1-11
A	GB 1594183 A (STANDARD TELEPHONES AND CABLES LIMITED), 30 July 1981 (30.07.81)	1-11
A	EP 0655804 A2 (ITT INDUSTRIES, INC.), 31 May 1995 (31.05.95)	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/02/98

International application No.
PCT/NO 97/00301

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